

# Economic reforms, technological intensity and industrial development in India

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The impact of the 1991 reforms on the Indian manufacturing sector has been a subject of much debate. The reforms were expected to result in a high growth rate coupled with a structural change towards high technology industries. This paper analyses data on 60 three-digit industries, reclassified into four technology-intensive subgroups, for the period 1980-81 to 2005-06. Dividing this period into the pre-reform (1980-81 to 1991-92) and the post-reform (1992-93 to 2005-06), the paper uses the single kinked model to reveal a slower trend growth rate of value added for about 77% of the industries in the post-reform period. Further, the study does not find any significant structural transformations within the organised manufacturing sector, which is still dominated by relatively low technology industries. The results thus refute the neo-liberal optimism regarding reforms. In an increasingly technology-driven world, promoting industrialisation is a multidimensional complex task that requires a constructive role of the government.

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## 1 Introduction

Empirical evidence[1] and scholarly opinion[2] on the impact of the infamous "Washington Consensus"[3] remain divided the world over. A similar scepticism is observed in the literature on the impact of reforms in India. Before we present the divergent views on this crucial policy issue, it is perhaps important to sketch a brief background to the reforms process.

India protected her industrial sector for about three decades[4] before its shackles[5] began to erode in the early 1980s (Singh 2009) following the proposals by the neo-liberal studies of the time,[6] as need arose to correct the stagnant growth in the sector. However, the changes were too hesitant (Rodrik and Subramanian 2004), reluctant, intermittent and patchy (Lall 2001) to call them the "real reforms" until the bold economic reforms implemented by the government (Singh 2009) in 1991. But now, after having adopted massive reforms for about a decade and a half, and after having seen the initial optimism around these reforms (Pack 1988), the paper aims to test the hypothesis that the reforms have had a positive effect on the industrial sector, in the sense of a sustainable higher growth rate. A high growth rate is sustainable if industrial activity is diversified from simple to advanced technological activities as (i) technology-intensive activities enjoy faster growth in demand due to their higher income elasticity of demand; and (ii) these are less vulnerable to easy entry by competitors (Lall 2001).

In this context, this study aims to analyse (i) whether the trend growth rate of the manufacturing sector increases after the adoption of the 1991 reforms and (ii) if there is a technological upgradation within the manufacturing sector. While numerous studies have been conducted by scholars on this issue, so far the results have been mixed.

In the realm of comparative studies, Nagaraj (1997, 2003) and Chaudhuri (2002) found that the growth rate in the manufacturing sector is lower in the post-reform period than in the pre-reform years. Ahluwalia (2006) also observed a deceleration in the growth of value added in the manufacturing industry at the aggregate level. Though the results are quite similar, the reasoning seems to diverge – while Nagaraj (1997, 2003) attributes it to the decline in the role of the government, Ahluwalia (2006) explains the deceleration in terms of a slowdown in reforms. Second, studies by Rodrik and Subramanian (2004), Nayyar (2008) and Singh (2009) found that after the acceleration of growth during the 1980s, the industrial sector did not witness any such break thereafter, not even after the massive reforms of the early 1990s. An earlier study of the Indian organised manufacturing sector by

Ahluwalia (1991) did find signs of growth in this sector following the reforms of the 1980s, and attributed this growth to the liberal policy moves. However, the study by Rodrik and Subramanian (2004) refuted this view by describing the reforms of the early 1980s as a mere change in the attitude of the government towards enhancing business. Their study found that the distance from the production possibility frontier was responsible for the growth rather than the reforms as advocated by Ahluwalia (1991). But Nayyar (2008) argues that acceleration of growth in the 1980s was actually the result of several conducive factors rather than mere reforms or the attitudinal shift.

In a recent study, Singh (2008) argued that the industrial sector has lagged behind since the reforms. Its contribution to the gross domestic product (GDP) remained about the same at 16% throughout the period 1980 to 2002. Thus, he regarded the "impediments to internal trade, labour market rigidities, and barriers in doing business" responsible for hampering further growth in industry.

Thus, the brief literature review reveals the complexity of the issue as no consensus seems to evolve regarding the impact of the reforms on the Indian manufacturing sector. We attempt a fresh analysis of different technology-intensive industrial subgroups of the organised manufacturing sector pre- and post-reforms.

The structure of the paper is as follows. Section 2 describes the rationale for the data sources and methodology used in the study. The question of structural break in the data series is addressed in Section 3. Section 4 deals with estimation and analysis of the trend growth rate of the manufacturing sector and its technological complexity. Section 5 concludes the study by presenting some policy implications.

## 2 Database and Methodology

The analysis is based on data from 60 industries from 1980-81 to 2005-06 drawn from the electronic database of the EPW Research Foundation (EPWRF) (Vol 2). This is based on the *Annual Survey of Industries* (ASI) data published by Central Statistical Organisation (CSO), which is the original data source for statistics on the organised industrial sector in India. We selected this source as it presents a systematic and consistent data set after doing the concordance for the different National Industrial Classification (NICS) that came up during the period (see Appendix 1, p 67) – NIC 1970 functioned till 1988-89; NIC 1987 was for the period 1989-90 to 1997-98; while NIC 1998 was for the period 1998-99 to 2003-04. Moreover, industrial classification changed again to NIC 2004 during 2003-04 to 2005-06. But on comparing the industrial codes at the 3-digit level of disaggregation for NIC 1998 and NIC 2004, we did not find any change therein.[7] So the data series can be safely regarded as based on the NIC 2004. Since, the period of analysis is up to 2005-06, and the EPWRF data set is available only till 2003-04; we have taken data directly from ASI for the years 2004-05 and 2005-06.

Since the objective of the study is to ascertain the impact of reforms on different technology-intensive industrial subgroups, the reclassification into high-technology (HT), medium-high technology (MHT), medium-low technology (MLT) and low-technology (LT) was done according to the technology-based classification provided by the Organisation for Economic Cooperation and Development (OECD 2007).

While doing this classification, it was found that one industry – pharmaceuticals (NIC 2004 code 2423) falls in the HT subgroup, while its 3-digit subgroup "other chemical products" (NIC 2004 code 242) is a part of the MHT subgroup. Thus, a separate series was developed for pharmaceuticals (NIC 2004 code 2423) at the 4-digit level of disaggregation for the period 1980-81 to 2003-04 (the most recent year for which this data was available).[8] The concordance for "pharmaceuticals" is done for the four different NIC classifications – as according to NIC 1970, pharmaceutical has the industrial code of 313; for NIC 1987, it is 304 and subsequently for NIC 1998 and NIC 2004, it is 2423. Again to avoid double counting in the data set, the values for the variables for the pharmaceuticals (NIC 2004 code 2423) was subtracted from the values of the variables for the "other chemical products" (NIC 2004 code 242). Thus, the study is based on the data for 59 3-digit industries and one 4-digit industry.

First, to ascertain the impact of reforms of 1991 on the organised manufacturing industry in India, it is worth comparing the pre-reform and post-reform growth scenario. For a complete analysis, an attempt is made to find out the structural break, if any, in the series pertaining to the sector under study using the "cusum of square test". These regression estimates which generate the recursive residuals[9] entail the inclusion of two explanatory variables. Two primary inputs, labour and capital, are used in the study. As a measure of labour, we use total persons engaged, and for capital, we generate the gross fixed capital stock using the perpetual inventory method (Appendix II, p 68).

The data is at 1993-94 prices. Using the wholesale price indices for different industrial products (Appendix III, p 68) consistent series were generated after splicing. We used published data from the Ministry of Industry for the purpose.

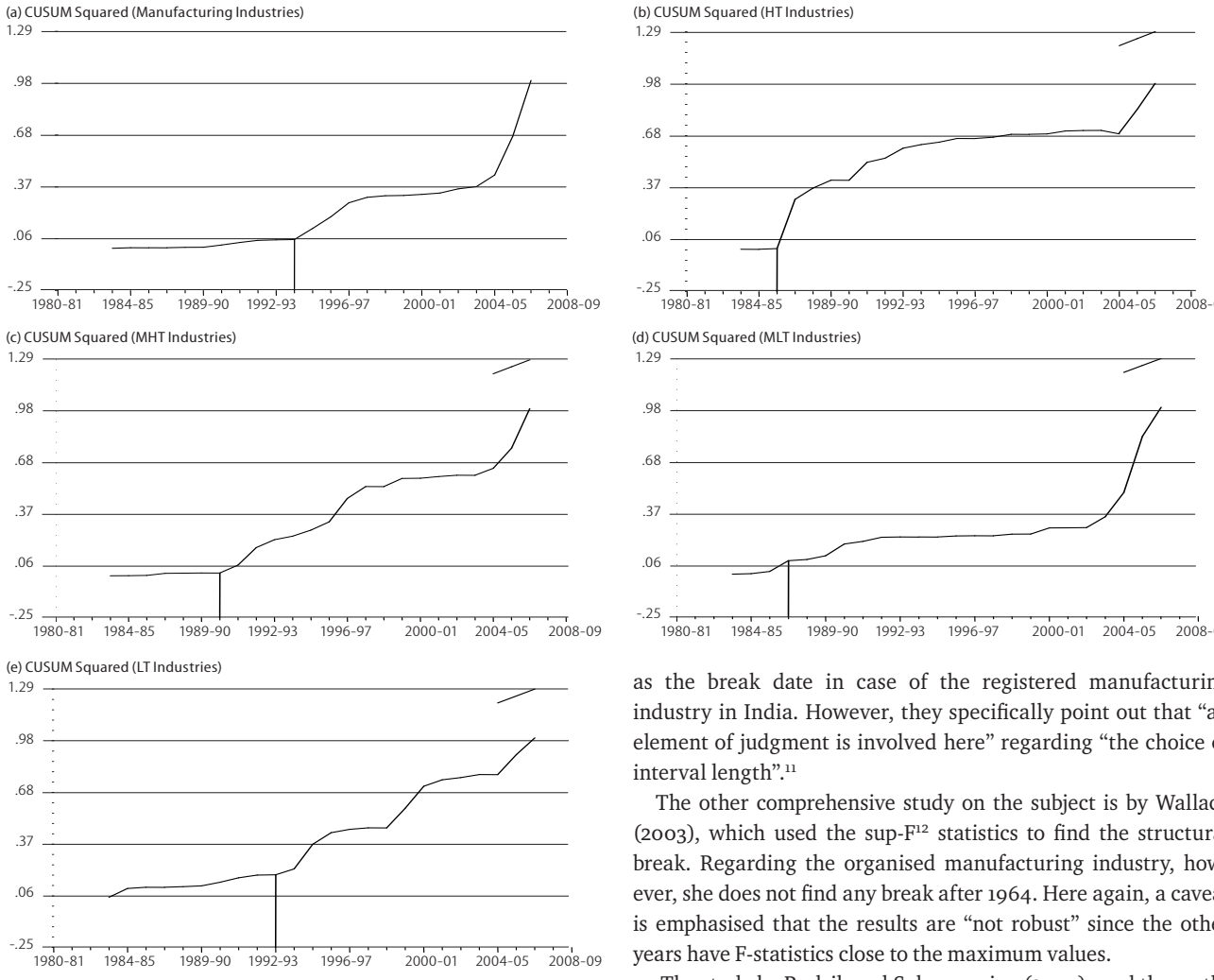
Regarding the methodology for estimating the trend growth rates for the period 1980-81 to 2005-06, a semi-logarithmic regression model is used to get the compound trend growth rate. This log-linear method is also used by Ahluwalia (1985, 1991) and Nagaraj (1997, 2003).

Second, for estimating the trend growth rates in the sub-periods of the time series, the empirical exercises in the literature (notably of Ahluwalia 1985, 1991) had fitted separate exponential trend lines by the ordinary least squares method for each sub-period of the series, which gave anomalous results (Goldar and Seth 1989). So, "to make use of the full information" and to avoid asymmetry and discontinuous bias (ibid), we use a single kinked model in our study. In this method only one regression equation is estimated instead of estimating separate regression equations for different sub-periods for better analytical estimates. The model can be derived using a simple equation as follows:

$$\text{Log } Y_1 = a_1 D_1 + a_2 D_2 + (b_1 D_1 + b_2 D_2)\, t + u_1 \qquad \ldots(1)$$

where $Y_1$ is real net value added, time t = 1, ....., n is broken at point $k$, $D_{jt}$ (j = 1, 2) is dummy variable which takes the value 1 in the $j^{th}$ subgroup and 0 otherwise and $u_1$ being the error term.

**Figure 1: Estimation of Structural Break**




To avoid the discontinuity, a linear restriction of interaction of two trend lines at "*k*" is imposed, such that

$$a_1 + b_1 k = a_2 + b_2 k \qquad \ldots(2)$$

Now substituting in (1) the value of $a_2$ from (2) and assuming $a_1 D_1 + a_1 D_2 = a_1$, we get

$$\log y_1 = a_1 + b_1 (D_1 t + D_2 k) + b_2 (D_2 t - D_2 k) + u_t \qquad \ldots(3)$$

The estimates for $b_1$ and $b_2$ give the exponential growth rate for the two sub-periods.

The same technique can also be used to derive a generalised kinked exponential model for *m* sub-periods and *m-1* kinks (Boyce 1986; Goldar and Seth 1989).

## 3 Structural Break

There are usually two major approaches to identify a structural break in the data series. The first is to use an econometric technique which causes an inflexion in the graph series, while the second is the occurrence of some exogenous event which is expected to cause the structural change.

Following the methodology by Bai and Pierre[10] (1998), Balakrishnan and Parameswaran (2007) found the year 1994-95 as the break date in case of the registered manufacturing industry in India. However, they specifically point out that "an element of judgment is involved here" regarding "the choice of interval length".[11]

The other comprehensive study on the subject is by Wallack (2003), which used the sup-F[12] statistics to find the structural break. Regarding the organised manufacturing industry, however, she does not find any break after 1964. Here again, a caveat is emphasised that the results are "not robust" since the other years have F-statistics close to the maximum values.

The study by Rodrik and Subramanian (2004) used the methodology by Bai and Pierre (1998), and did not find any structural break in India's economic growth after 1980 while the study by Nayyar (2008) emphasised that the structural break of the early 1950s is much more significant for both polity and economy of India than any such break that followed it.

Since no clear consensus has emerged from the literature on the subject of determining the structural break date for the organised manufacturing industry in India, we attempt the same using the cusum of square test. This test was based on the methodology developed by Brown et al (1975) where the recursive residuals are estimated from the regression analysis to test the parameter consistency (Johnston and DiNardo 1997). Figure 1 shows whether the parameters are consistent or not, for the organised manufacturing industry.

Figure 1 shows the structural break for the organised manufacturing industry and its various sub-sectors. Figure 1(a) shows 1993-94 to be the break-date for the organised manufacturing industry, 1985-86 for the HT industries (Figure 1b), 1989-90 for the MHT industries (Figure 1c), 1986-87 for the MLT industries (Figure 1d), and 1992-93 for the LT industries (Figure 1e). This clearly reveals that it is not possible to regard one particular structural break-date in the series with respect to the industrial

sector as a whole, as the break-date is different for each industrial subgroup and even for individual industries.[13]

However, based on the literature survey on the subject and the results obtained by this econometric exercise, it seems probable that the exogenous factor which could be taken as the basis for dividing the data series, are the economic reforms of 1991. We thus divide the series into pre-reform period (1980-81 to 1991-92) and post-reform period (1992-93 to 2005-06).

## 4 Organised Manufacturing Industry: Trend Growth Rate

The changing structure of the 60 industries and four technology-intensive subgroups for the different time periods, viz, 1980-83, 1990-93, 2000-03 and 2003-06 is estimated using the real net value added in Table 1.

Further, Table 1 also shows the trend growth rates for the respective industries and the subgroups, first, for the two sub-periods, that is, pre-reform and post-reform period using the single kinked model; and second, for the overall period (1980-2006) using the semi-logarithmic method.

Some important results emerge from Table 1. Within the HT industries, pharmaceuticals (2423)[14] with a weight of around 3% in the 1980s and around 6% during the early 2000s, witnessed the highest drop in its trend growth rate – from 17.2% in the pre-reform period to even less than 1% in the post-reform period, although the data for this industry is available only until 2003-04. This sharp fall can be attributed to the lack of investment in research and development (R&D) in the wake of a high competitive environment of the 1990s. Moreover, whatever investment was made in the sector was in reverse engineering rather than in developing new products (Lalitha 2002) which does not lead to sustainable growth. The other industries which saw a drastic fall in the trend growth rate are TV and radio transmitters, watches and clocks, and aircrafts and spacecrafts. However, amongst the nine HT industries, only two showed

**Table 1: Value Added and Trend Growth Rates of Organised Manufacturing Sector (3-Digit Disaggregated Level)** (in %)

| NIC 2004 Code | Industry | Proportionate Value Added | | | | Trend Growth Rates | | |
|---|---|---|---|---|---|---|---|---|
| | | 1980-83 | 1990-93 | 2000-03 | 2003-06 | Pre-reform | Post-reform | 1980-2006 |
| High technology | | | | | | | | |
| 2423 | Pharmaceutical | 3.25 | 3.6 | 5.8 | 4.35 | 17.2 | 0.8 | 5.02 |
| 300 | Office, accounting and computer machinery | 0.68 | 0.97 | 0.67 | 1.27 | 18.88 | 10.8 | 11.8 |
| 321 | Electronic valves and tubes | 0.11 | 0.26 | 0.95 | 0.38 | 12.1 | 8.11 | 10.2 |
| 322 | TV and radio transmitters | - | 1.51 | 0.45 | 0.38 | 21.3 | 2.7 | 9.2 |
| 323 | TV and radio receivers | 1.07 | 0.78 | 0.93 | 0.6 | 15.3 | 10.7 | 12.5 |
| 331 | Medical appliances | 0.86 | 0.48 | 0.77 | 0.73 | 2.6 | 10.6 | 7.5 |
| 332 | Optical instrument | 0.03 | 0.02 | 0.08 | 0.11 | 6.8 | 16.2 | 13.5 |
| 333 | Watches and clocks | 0.3 | 0.26 | 0.20 | 3.33 | 12.2 | 1.8 | 4.8 |
| 353 | Aircraft and spacecrafts | 0.17 | 0.21 | 0.06 | 0.1 | 17.2 | 0.8 | 5.02 |
| HT industries | | 6.51 | 8.15 | 9.93 | 11.3 | 10.85 | 6.29 | 8.87 |
| Medium high technology industries | | | | | | | | |
| 241 | Basic chemicals | 5.84 | 6.59 | 8.75 | 6.97 | 14.9 | 2.4 | 8.4 |
| 242* | Other chemical products | 5.17 | 5.31 | 5.05 | 3.75 | 11.62 | 1.5 | 6.07 |
| 243 | Man-made fibres | - | 0.75 | 0.92 | 0.39 | -7.3 | 0.0 | -10.6 |
| 291 | General purpose mach | 3.27 | 3.08 | 3.07 | 2.87 | 7.8 | 8.1 | 8.0 |
| 292 | Special purpose mach | 4.62 | 3.9 | 2.73 | 2.47 | 6.82 | 4.81 | 5.76 |
| 293 | Domestic appliances | 1.07 | 0.45 | 0.47 | 0.25 | 1.8 | 3.67 | 2.9 |
| 311 | Electronic motors, etc | 3.29 | 2.75 | 1.37 | 1.56 | 6.9 | 2.3 | 4.3 |
| 312 | Electricity distribution and control appliances | 0.39 | 1.03 | 0.87 | 0.87 | 18.2 | 10.3 | 13.3 |
| 313 | Insulated wires and cables | 1.27 | 0.97 | 0.55 | 0.32 | 12.3 | 0.2 | 4.5 |
| 314 | Accumulators, cells, etc | 0.54 | 0.36 | 0.49 | 0.3 | 5.97 | 7.46 | 6.9 |
| 315 | Electronic lamps, etc | - | 0.34 | 0.23 | 0.18 | - | 9.82 | - |
| 319 | Other electrical equip | 0.25 | 0.15 | 0.26 | 0.32 | - | 8.8 | - |
| 341 | Motor vehicles | 4.87 | 4.38 | 1.65 | 4.1 | 10.1 | 1.0 | 5.12 |
| 342 | Bodies for motor vehicle | 0.1 | 0.15 | 0.05 | 0.09 | 19.12 | 3.66 | 7.35 |
| 343 | Parts for vehicles | - | - | 2.49 | 2.74 | - | - | - |
| 352 | Railways and tramways, etc | 2.12 | 1.77 | 0.23 | 0.22 | 8.98 | -8.88 | -3.34 |
| 359 | Transport equipment nec | 0.88 | 1.45 | 2.42 | 2.66 | 12.75 | 13.4 | 13.08 |
| MHT industries | | 33.1 | 33.46 | 31.63 | 30.13 | 7.68 | 3.14 | 5.75 |
| Medium low technology industries | | | | | | | | |
| 231 | Coke-oven products | 0.65 | 0.45 | 0.24 | 0.55 | 9.75 | 5.65 | 7.03 |
| 232 | Refined petroleum products | 2.57 | 4.39 | 6.94 | 12.42 | 16.1 | 10.6 | 13.3 |
| 233 | Process of nuclear fuel | - | 0.005 | - | - | - | - | - |
| 251 | Rubber products | 1.76 | 1.94 | 1.72 | 1.24 | 8.76 | 3.77 | 5.87 |
| 252 | Plastic products | 0.67 | 1.28 | 1.79 | 1.48 | 14.9 | 9.2 | 11.6 |
| 261 | Glass and glass products | 0.52 | 0.53 | 0.54 | 0.44 | 8.11 | 5.86 | 6.71 |
| 269 | Non-metallic mineral | 3.96 | 4.98 | 4.58 | 3.93 | 8.54 | 5.86 | 7.14 |
| 271 | Basic iron ore and steel | 12.36 | 7.97 | 6.79 | 12.51 | 3.35 | 7.57 | 5.44 |
| 272 | Basic and non-ferrous metal | 0.88 | 1.96 | 2.37 | 2.76 | 17.2 | 7.78 | 11.8 |
| 273 | Casting of metals | - | 0.97 | 0.71 | 0.69 | - | 11.1 | - |
| 281 | Structural metal, etc | 1.59 | 1.54 | 0.99 | 1.13 | 6.5 | 2.32 | 3.9 |
| 289 | Fabricated metal, etc | 1.41 | 1.39 | 1.73 | 1.55 | 6.5 | 8.32 | 7.57 |
| 351 | Building and repair of ships | 0.87 | 0.21 | 0.23 | 0.18 | -10.6 | 7.14 | 1.41 |
| MLT industries | | 27.3 | 27.66 | 28.61 | 38.89 | 6.82 | 8.98 | 7.68 |
| Low technology industries | | | | | | | | |
| 151 | Production and process of meat | 1.5 | 1.69 | 1.55 | 1.2 | 10.8 | 3.5 | 6.5 |
| 152 | Dairy products | 0.45 | 0.67 | 1.43 | 0.97 | 15.6 | 9.3 | 11.7 |
| 153 | Grain mill products | 1.15 | 1.23 | 1.55 | 1.22 | 9.1 | 6.6 | 7.6 |
| 154 | Other food products | 4.85 | 5.21 | 4.97 | 3.18 | 10.1 | 1.3 | 5.4 |
| 155 | Beverages | 0.71 | 1.06 | 1.21 | 1.06 | 9.8 | 4.5 | 6.6 |
| 160 | Tobacco products | 1.36 | 2.16 | 2.83 | 2.02 | 8.1 | 5.12 | 6.4 |
| 171 | Spin, weaving of textiles | 15.82 | 10.33 | 6.48 | 4.77 | 4.3 | 2.7 | 3.5 |
| 172 | Other textiles | 0.51 | 0.44 | 0.71 | 0.68 | 4.8 | 13.8 | 10.3 |
| 173 | Knitted and crochet fabrics | 0.22 | 0.39 | 0.63 | 0.61 | 15.4 | 13.2 | 13.9 |
| 181 | Wearing apparel, not fur | 0.48 | 1.58 | 2.12 | 1.74 | 26.5 | 8.8 | 16.3 |
| 182 | Dressing and dying of fur | 0.004 | 0.01 | 0.004 | 0.004 | 22.8 | 6.4 | 7.9 |
| 191 | Leather | 0.33 | 0.47 | 0.26 | 0.22 | 11.4 | 2.9 | 5.5 |

*(Continued)*

**Table 1: Value Added and Trend Growth Rates of Organised Manufacturing Sector (3-Digit Disaggregated level)** *(Continued)*

| NIC 2004 Code | Industry | Proportionate Value Added | | | | Trend Growth Rates | | |
|---|---|---|---|---|---|---|---|---|
| | | 1980-83 | 1990-93 | 2000-03 | 2003-06 | Pre-reform | Post-reform | 1980-2006 |
| 192 | Footwear | 0.38 | 0.66 | 0.56 | 0.41 | 13.5 | 5.2 | 8.1 |
| 201 | Saw milling of wood | 0.16 | 0.08 | 0.03 | 0.01 | -2.2 | -5.5 | -4.9 |
| 202 | Wood, cork and straw | 0.36 | 0.29 | 0.19 | 0.19 | 3.4 | 1.8 | 2.2 |
| 210 | Paper and paper products | 1.93 | 2.13 | 2.18 | 1.46 | 7.3 | 3.6 | 5.12 |
| 221 | Publishing | 1.42 | 1.15 | 1.0 | 0.93 | 4.2 | 3.7 | 3.9 |
| 222 | Printing | 0.69 | 0.47 | 0.56 | 0.43 | 1.9 | 5.02 | 3.9 |
| 223 | Reprod recorded media | - | - | 0.02 | 0.003 | - | - | - |
| 361 | Furnishing | 0.34 | 0.1 | 0.26 | 0.24 | -7.2 | 9.3 | 3.9 |
| 369 | Manufacturing nec jewellery | 0.42 | 0.58 | 1.24 | 1.19 | 9.7 | 11.5 | 10.8 |
| LT industries | | 33.1 | 30.72 | 29.81 | 22.58 | 7.04 | 4.19 | 5.87 |
| Organised manufacturing# | | 100 | 100 | 100 | 100 | 7.25 | 5.33 | 6.6 |

* Means 'Other chemical products' (242) does not include pharmaceuticals (2423).
The average of three years is taken to overcome yearly fluctuations, if any.
Real value added in 1980-83 is Rs 12,06,990 crore; rose by 3% to Rs 49,27,123 crore in 1990-93; rose further by 2% to Rs 1,50,54,897 crore in 2000-03 and by 0.6% to Rs 2,50,54,306 in 2003-06.
# Means that the value added may diverge from the sum due to round off errors.
Source: Calculated. EPWRF CD-ROM, 2004 and ASI (CSO), 2005, 2006.

an increased trend growth rate in the post-reform era. These are medical appliances and optical instruments, with an average weight being 0.7% and 0.06% respectively, throughout the period.

Within the subgroup of MHT industries, a steep fall is seen in the trend growth of basic chemicals (an important industry in terms of weight – around 7% throughout the period 1980-2006), other chemical products (242 minus 2423), insulated wires and cables, motor vehicles, and bodies for motor vehicles. All these had double digit growth rates in the pre-reform period, but in the post-reform years, their growth rates reached a level of less than 4%, which subsequently had a negative impact on their weight amongst the manufacturing industries. The Indian automobile industry achieved a significant production volume only in the mid-1980s with the setting up of Maruti Udyog in collaboration with Suzuki Motors of Japan (Mukherjee and Sastry 1996). But in the era of deregulation beginning in the early 1990s, the lack of investment in R&D and specific government policies for supporting industry and technology transfer, etc, hampered the growth, in this industry. The industries which show a higher trend growth rate in the post-reform era in this subgroup are man-made fibres, general purpose machinery, domestic appliances, accumulators, etc, and transport equipment (with the average weight for these five industries for the entire period around 9%).

The only industrial subgroup which witnessed an overall rise in the trend growth rate in the post-reform period is the MLT industry. This was basically due to the rise in the trend growth rate of its most important industry – basic iron ore and steel. India is the fourth largest producer of iron-ore in the world. This industry had a share of 12.4% in the total organised manufacturing sector in the early 1980s. However, this fell by nearly half to 6.8% in 2000-03 due to large inefficiencies in the industry, lower investment in R&D and also due to various external factors such as the economic crisis in Russia and the financial crisis in Asia (Firoz 2003; Rohini 2004). But it regained its earlier position during 2003-06 mainly due to demand from the indigenous infrastructure sector and also from China (Rohini 2004). The other industries which showed a positive growth trend in the post-reform period are casting of metals, fabricated metal, etc, and building and repair of ships. All other industries in this subgroup witnessed a slower trend growth rate in the post-reform period.

The lowest position in the technological complexity structure is that of the LT industries. This subgroup is the largest in terms of the number of 3-digit industries. All except four industries witnessed an overall fall in the trend growth rate in the post-reform era. These are other textiles, printing, furnishing and manufacturing not elsewhere classified (nec) jewellery, with the total average weight of merely 1% throughout the period under study.

Thus the analysis shows that amongst the 60 industries, only 14 industries, with an average weight of less than 20% for the period, showed an increase in their trend growth rate in the post-reform period. This clearly shows that there is a deceleration in around 77% of the industries in the post-reform period.

At the aggregate level, Table 1 shows a significant slowdown in the growth of the entire industrial sector after the adoption of the structural adjustment programme. The trend growth rate, which was 7.25% during the pre-reform period, fell to 5.33% in the post-reform period. Except the MLT industry subgroup, all others showed a deceleration in the growth rate during the post-reform period, to the tune of around 45%. In the MLT industrial subgroup, the trend growth rate accelerated from 6.82% in the pre-reform period to 8.98% in the post-reform period. The high growth of the MLT industries in the post-reform period could be attributed to the higher trend growth rate witnessed in the basic iron and steel industry which could be the result of the Mahalanobis model, under which conscious efforts were made to build capacity in this core intermediate goods sector (Ahluwalia 1991).

Coming to the HT and MHT industries, the trend growth rate fell from 10.85% and 7.68% in the pre-reform period to 6.29% and 3.14% in the post-reform period, respectively. This slower growth rate could perhaps imply that there is a paucity of technological capacity in these industries on the supply side, the easy flow of which was implicit in the trade liberalisation theories prescribed by the market-fundamentalists (Pack 1988). This clearly signifies the tacit aspect of knowledge which makes its transmission rather sticky. Indeed, this is one of the fundamental reasons why technological catch-up remains a challenge in the era of globalisation (Cimoli et al 2009). On the demand side, these industries lack competitiveness[15] both in the domestic market and foreign markets (since market is no longer the constraint for a competitive industry in a globalised environment).

The LT industries on the lowest rung among the technology intensive industries also witnessed a fall from 7.04% in the pre-reform period to 4.19% in the post-reform period; which again could be the result of technological stagnation and also due to its direct linkage with the agriculture sector. The poor agriculture performance in the post-reform period (Nagaraj 1997, 2003)

imposed a demand as well as a supply constraint on these industries. To sum up, all the technology intensive subgroups, except the MLT industrial subgroup, witnessed a deceleration in their trend growth rate in the post-reform period.

Before moving on to the question of a structural transformation within the manufacturing industries, there is a need to understand the importance of such transformations. Structural transformation towards the high value added and technology intensive products (Akyuz 2009) is a manifestation of successful and sustainable industrialisation as it entails higher income elasticity of demand (Lall 2001) and gainful employment (Edquist et al 2001). However, this transformation is not automatic since it is an interrelated process of various demand and supply factors[16] (Chenery et al 1986).

In relation to this, Table 1 shows that the average contribution of HT industry towards the net value addition of the organised manufacturing during 1980-83 was 6.5% whereas the LT and MHT industries contributed a whopping 33%. The decade of reforms seemed to have had a positive effect on the HT industries, increasing its contribution by about 3 percentage points, bringing the total average contribution to 10% during 2000-03, and further to 11.3% during 2003-06. Similarly, the MLT subgroup witnessed a gradual but consistent increase between 1980-83 (27%) and 2000-03 (29%), and thereafter a sharp increase by 10 percentage points to 39% in 2003-06. However, LT and MHT industries witnessed some fall in their shares in contribution in the post-reform period. To arrive at a more conclusive picture, we combine the relative shares of HT and MHT groups. Their share increased from 39.6% during 1980-83 to 41.5% during 1990-91, though this remained stagnant at 41.4% in 2003-06. The combined share of MLT and LT industries was 60.4% during 1980-83, and fell to 58.4% during 1990-93. This increased again in the post-reform period to 61.5% during 2003-06. This shows that the dramatic structural change which was expected as a result of economic reforms did not take place. The relatively low-technology groups still show the largest contribution to the value added in the organised manufacturing sector. The meagre quantum of investment in R&D is the important factor for this pattern of industrial growth. In 1990-91, only 0.8% of GDP was devoted to R&D and the industry as a whole spent only 0.21% of the GDP on R&D (Department of Science and Technology 1992). But despite entering the highly competitive environment driven by technology, the rates of R&D investment remained stagnant at the same levels even a decade later in 2000-01 (ibid: 2006). This compares unfavourably with other developing countries like China (1.23% 2000-01) and Brazil (1.04% in 2000-01).

Thus, the overall results of the analysis show that (i) the overall trend growth rate of the organised manufacturing sector does not witnesses an acceleration after the adoption of the reforms in 1991; (ii) the trend growth rate of HT and MHT industries also decelerated in the post-reform period, which threatens the industrial sustainability; and (iii) the increase in the weight of HT industries from 1980s to 2000s is too small, which was seen to be somewhat offset by the fall in the weight of MHT industries; which renders an overall gloomy scenario. A similar reshuffle was also witnessed for the MLT and LT industries.

Thus the overall results seem to refute the assumed hypothesis of a positive effect of reforms on the Indian organised manufacturing sector.

## 5 Conclusions

We have attempted to assess the impact of the 1991 policy reforms on the industrial sector through a technology-based classification of the organised manufacturing sector for the period 1980-81 to 2005-06. The analysis shows a slower trend growth rate of value added in the post-reform period. Further, though the study does find some positive signs of a structural shift within the manufacturing sector, the changes are too small to have any significant impact.

It is perhaps essential to explore the possible reasons for these results, by engaging with the ongoing debate on the subject. The debate regarding the question of reforms started as early as the mid-1960s when the industrial growth stagnated (Ahluwalia 1991). In fact, three separate occasions witnessed the move towards liberalisation, although in each subsequent move the quantum of reforms increased. The first was in 1966 following two wars and a severe drought. The second was in 1980 following the oil crisis and ultimately in 1991 following the balance of payment crisis. Each of these occasions called for dependence on foreign aid to come out of the crisis, and this was provided only after agreeing to the conditions of the donor institutions[17] – the International Monetary Fund and World Bank. Thus, in India, the crisis was the cause for the reforms. This simply means that the industry was pressurised to open up without actually being prepared for it. This is in contrast to the export-oriented policies strategically and willingly pursued by the successful east Asian economies[18] (which are always cited by neo-liberals as role models for pursuing these liberalisation moves).

Importantly, it is this "forced globalisation" which has hampered the growth in this sector, which is popularly contested by the orthodoxy. These results are not unique to the Indian manufacturing industry. China and Latin American countries have both followed reforms, though at a different pace and with different results. China, which has been a high performer, was one among the "most protected countries in the 1990s" (Castaldi et al 2009), while Latin American countries which followed all the prescriptions of the Washington Consensus failed miserably (Stiglitz 2006; Lee 2006; Castaldi et al 2009). Explaining this phenomenon, Cimoli et al (2009) remarked:

> Certainly, the certain liberalisation process together with orthodox macro policies in Latin America had a massive 'weeding out' effect. However, there is no guarantee – either in biology or even less so in economics – that a major selection shock allows any one species to survive.

Thus, "reforms" cannot be considered as the sole means of achieving a higher industrial growth trajectory. There is a vast amount of literature to refute this myopic view of the neo-liberal policymakers (Pack 1988; Stiglitz 2006; Maio 2009; Castaldi et al 2009; Cimoli et al 2009).

Similarly, the present study also does not find any significant impact of the 1991 reforms on the organised manufacturing sector.

In fact, various factors are actually hampering the industrial growth in India – the lack of infrastructure, technology, and skilled labour force (Singh 2008; Dahlman 2008). The sector requires investment in infrastructure, R&D and education among other things, to enhance its absorptive capacity for reaping the benefits of globalisation (Lall 2001; Stiglitz 2006). For this, the role of the government becomes paramount. Rather, in an increasingly globalised and technologically advancing world, promoting industrialisation and growth is a multidimensional complex task that requires coordination from the government at various levels (Singh 2009).

Thus, for sustainable growth, a correct mix of market and government (Stiglitz 2006) should be formulated for each industry, especially for the high technology industries. The policy framework for the overall manufacturing sector should be unique for each industry concerned, ranging comprehensively from specific technology-generating, technology-acquiring and specific capability building approaches.

## NOTES

1 Empirical evidence regarding the spectacular Chinese growth and the lacklustre growth in Latin American and African countries after adopting structural reforms in the respective countries (Stiglitz 2006).

2 Refer the views of Rodrik (2008), Stiglitz (2006) versus the views of market fundamentalists like Bhagwati and Srinivasan (Singh 2009).

3 The term "Washington Consensus" was originally coined by John Williamson to describe the policy reforms in Latin America. This consensus is forged between the International Monetary Fund (IMF), the World Bank, and the US Treasury; which emphasised downscaling of government, deregulation, and rapid liberalisation and privatisation, which would best promote development (Stiglitz 2006).

4 Except for the short lived liberalisation of the mid-1960s (Mukherji 2000).

5 During the earlier three decades from 1950-1980, this sector was protected through licensing, high tariffs, quotas, control on large private domestic firms in favour of public enterprises, government investment and so on (Lall 2001).

6 Alexander (1978) and Dalgi (1979) and notably Ahluwalia (1985; 1991).

7 The introduction to the NIC '2004 (point 53), mentions that "the exercise does not affect any major changes in the structure of the existing classification", that is, NIC' 1998. Further, "the major structural changes required in the classification may be considered in the next revision of NIC" (point 54).

8 For this the data was taken directly from the various issues of ASI as EPWRF did not provide the data at the 4-digit disaggregated level.

9 For estimating the recursive residuals, first fit the model to the first k observation for k regression coefficients. Next use the first k+1 data points to compute the coefficient vector again. Repeat the process till the final coefficient vector, n. Thus, the standard errors of various coefficients are computed at each stage of recursion (Johnston and DiNardo 1997).

10 The break dates are estimated as minimisers of sum of squared residuals but after assuming the length of the segments and thus, the number of break points.

11 However, they regarded that the estimates are invariant to the length = 4, 5, or 8 only.

12 The methodology consists of taking all possible structural break dates and calculating each possible F-statistics and using the maximum of these statistics to choose the initial break date and then by repeating the process for additional break dates.

13 Similar results were accrued by estimating the cusum square test for individual industries.

14 The figure in bracket following the industry name is the NIC 2004 (NIC'04) industrial code.

15 Competitiveness in industrial activities implies developing relative efficiency along with sustainable growth. Building industrial competitiveness consists of moving away from static sources of cost advantage and moving up the higher technological ladder (Lall 2001).

16 Composition of demand, trade production, employment, initial conditions and government policies all work in tandem to generate the transformation towards the high technology products.

17 On the occasion of the 1966 devaluation, the prime minister reasoned, "…without denying that the IMF and World Bank had advised in favour of devaluation…" India received $1.6 billion of foreign aid by USAID of which $900 million was to be set aside for the imports (Raj 1976). The policy change in 1980-81 is associated with a $5 billion IMF credit after the second oil shock (Nagaraj 1997). The 1991 reforms were initiated as a part of mutually negotiated conditionalities associated with the bailout packages from the IMF and World Bank (Lee 2006).

18 See Dahlman (2008).

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## Appendix I

| Concordance between NIC'04,NIC'98 and NIC'87 | | Concordance between NIC'87 and NIC'70 | |
|---|---|---|---|
| NIC'04 & NIC'98 | NIC'87 Code | NIC'87 Code | NIC'70 Code |
| 151 | 200+203+202+210+211+212 | 200-202 | 200-202 |
| 152 | 201 | 203 | 203-203.4 |
| 153 | 204+218+217 | 204-210 | 204-210 |
| 154 | 205+206+207+209+213+214+215+219 | 211 | 211+315.1 |
| 155 | 220+223+221+222+216+224 | 212 | 315.2+203.4 |
| 160 | 225+226+227+228+229 | 213-218 | 212-217 |
| 171 | 231+232+233+234+235+240+241+ 242+244+245+247+250+251+252+ 253+254+255+256+236+243+246+ 248+257+258+259 | 219-227 | 219-227 |
| 172 | 267+268+263+264+261+262+269 | 228 | 228+229 |
| 173 | 260 | 229 | NA |
| 181 | 265+266+292+964* | 230 | 230 |
| 182 | 294 + 295 + 296 + 299 | 231 | 233 |
| 191 | 290+293 | 232 | 234 |
| 192 | 291+311 | 233 | 235 |
| 201 | 270 | 234 | 236 |
| 202 | 271+272+273+274+275+279 | 235 | 231 |
| 210 | 280+281+282+283 | 236 | 232 |
| 221 | 285.2+284+285.3 | 239 | 239 |
| 222 | 285.1+286+289+287+288 | 240 | 240+249 |
| 223 | ND | 241 | 242 |
| 231 | 318+319 | 242 | 241 |
| 232 | 314+315+316 | 243 | 243 |
| 233 | 317 | 244 | 245 |
| 241 | 300+301-301.4+302 | 245 | |
| 242* | 301.4+303+208+305+307+308+309 | 246-248 | 246-248 |
| 2423 | 304 | 250 | 250 |
| 243 | 306 | 251 | NA |
| 251 | 310+312 | 252 | NA |
| 252 | 313-313.4 | 253 | 253 |
| 261 | 321 | 254 | 251 |
| 269 | 322+323++320++324 +327+329.1+329.2+329.3 329.5+325++326+329.4+329.6+329.7+329.9 | 255 | 268.1 |
| 271 | 330+331+332 | 256 | 253 |
| 272 | 333+334+335+336+338+339 | 257 | 252 |
| 273 | 337.1+337.2 | 258-259 | NA |
| 281 | 340+341+352.1+352.4+352.8+391 | 260 | 260 |
| 289 | 344+345+343+346-346.4-346.5-346.6+349 | 261 | 261+263.3 |
| 291 | 352.2+352.3+352.9+356.2+356.3+356.4+ 356.1+355-355.3+356.5+356.6+356.9+ 359.2+359.5+359.6+359.8+359.9 | 262 | 262 |
| 292 | 350+390+357+392+351++353.7+359.1+ 359.3+359.4+354+393-393.1+399 | 263 | 263+244 |
| 293 | 346.4+346.5+346.6+355.3+364+388 | 264 | 259+268.2 |
| 300 | 358+367 | 265 | 264 |
| 311 | 360-360.3+395 | 266 | 265-265.1 |
| 312 | 360.3 | 267 | 266 |
| 313 | 361 | 268 | 267 |
| 314 | 362 | 269 | 269 |
| 315 | 363 | 270 | 271 |
| 319 | 369-369.1 | 271 | 270 |
| 321 | 368 | 272 | 273 |
| 322 | 365-365.3+396 | 273 | 272 |
| 323 | 366 | 274-277 | 274-277 |
| 331 | 369.1+365.3+380 | 279-281 | 279-281 |
| 332 | 381 | 282 | 282+283 |
| 333 | 382 | 283 | NA |
| 341 | 373+374 | 284-299 | 284-299 |
| 342 | 379-379.8-379.9 | 300 | 310+312.3+ 316.1+316.7+ 314.7 |
| 343 | 379.8 | 301 | 311 |
| 351 | 370 | 302 | 316-316.1-316.5- 316.7-316.9 |
| 352 | 371+372+397 | 303 | 312-312.3 |
| 353 | 377 | 304 | 313 |
| 359 | 375+376+378+379.9 | 305 | 314-314.7 |
| 361 | 276+277+313.4+342 | 306 | 316.5+316.9 |
| 369 | 383+384+386+385+387+389 | 307-309 | 317-318 |
| | | 310-314 | 300-304 |
| | | 315 | 305 |
| | | 316 | |
| | | 317 | NA |
| | | 318 | 306 |
| | | 319 | 307 |
| | | 320 | 320 |
| | | 321 | 321-321.5 |
| | | 322 | 322+327 |
| | | 323-336 | 323-336 |
| | | 337 | 331 |
| | | 338 | 339 |
| | | 339 | |
| | | 340 | 341 |
| | | 341 | 340-340.5-340.6 |
| | | 342 | 342 |
| | | 343 | 343+349.3 |
| | | 344 | NA |
| | | 345 | 344 |
| | | 346 | 345+340.5+340.6 |
| | | 349 | 349-343.6 |
| | | 350-362 | 350-362 |
| | | 363 | 363 |
| | | 364 | |
| | | 365 | 364 |
| | | 366 | |
| | | 367 | 366-366.2 |
| | | 368 | 367 |
| | | 369 | 365+369 |
| | | 370-371 | 370-371 |
| | | 372 | 372+373 |
| | | 373 | 374 |
| | | 374 | |
| | | 375-379 | 375-379 |
| | | 380 | 380+366.2 |
| | | 381 | 381+321.5 |
| | | 382-387 | 382-387 |
| | | 388 | NA |
| | | 389 | 389+265.1 |
| | | 390-399 | NA |

ND means Not Defined separately in NIC'1987. NA means New . * Means Not covered by ASI till 1997-98.
Source: EPWRF, *Annual Survey of Industries*, Vol II.

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## Appendix II

### Perpetual Inventory Method

Let $B_t$ denote the book-value of fixed assets at time *t*, $D_t$ is the depreciation made in the year and *Pt* the capital good price index (machine and machine tools in the present case) for the year *t*, then the series on real fixed investment can be derived as

$$I_t = (B_t - B_{t-1} + D_t)/P_t$$

Further, the benchmark year estimate of gross fixed capital stock ($K_o$) at constant prices for the year 1980-81 is required; which was taken from the estimates of Balakrishnan and Pushpangadan (1994). Then, the capital stock series ($K_t$) is derived after subtracting the subsequently the annual rate of discarding which is assumed to be 0.02 of the last year's capital stock (Goldar 1986). Thus, the capital stock series assumes the form:

$$K_t = K_{t-1} + I_t \text{ or } K_T = K_o + \sum I_t$$

## Appendix III

| Industrial Group | NIC'2004 Industry Code | Deflators Wholesale Price Index (WPI) |
|---|---|---|
| H-T | 2423 | Drug and pharmaceuticals |
| | 300,321-323 | Electronics |
| | 331-333 | Machine and machine tools |
| | 353 | Transport equipment |
| M-H-T | 241-243 | Chemicals and chemical products |
| | 291-293 | Machine and machine tools |
| | 311-319 | Electronics |
| | 341-359 | Transport equipment |
| M-L-T | 231-233, 269 | Non-metallic products |
| | 251-252, 261 | Rubber and plastic products |
| | 271-73, 281-89, 351 | Metallic products |
| L-T | 151-54 | Food products |
| | 155, 160 | Beverages tobacco and tobacco products |
| | 171-73,181-82 | Textiles |
| | 191-92 | Leather and leather products |
| | 201-02, 210, 221-223, 361, 369 | Paper and paper products |

Names of NIC'2004 codes industries are presented in Table 1.